Dry Beneficiation Processing of Combustion Fly Ash

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SUMMARY

The loss-on-ignition (LOI) content of combustion fly ashes dictate to a large degree their commercial applicability within current markets. Because the LOI in most bituminous coal fly ashes is similar to their carbon content, the ability to efficiently extract high purity carbon or ash is important in the development and application of cost-effective beneficiation technologies for the production of value-added products. Beneficiation can be accomplished by using dry, triboelectrostatic technology. It relies on establishing a bipolar charge on the ash and carbon particles, typically with the carbon positive and the ash negative. However, it is possible to reverse this polarity, an effect of interparticle or particle-electrode charge exchange, thereby affecting the extent of beneficiation.

We report on charge exchange between carbon and ash, and between fine particles and electrode surfaces, and relate it to the development of pneumatic, triboelectrostatic beneficiation technology for fine particles, i.e. diameter < 100 μm. For this work, idealized spherical glass beads and fly ashes were subjected to triboelectrostatic beneficiation and to analytical examinations before and after testing.

The parent and tested samples were subjected to mineralogical, optical and scanning electron microscopic (SEM), and leachate analyses in an attempt to elucidate carbon-ash tribocharging and charge exchange. These data were obtained to elucidate why the distribution of products from ash beneficiation after exposure of the ash to water, whether it was soaking, filtering or even light spraying conditions, is nearly the opposite of the distribution of products before exposure to water. By visual examination or mass distribution data it is difficult to determine whether both carbon and ash reverse charge, or whether the carbon by itself reverses charge. We have been able to show, using an analytical laboratory-scale separator and controlled experiments with three different samples, that the charge reversal is predominantly affecting the carbon and not the ash.

The extent to which carbon particles are charged does not seem to be impacted by water exposure. However, this magnitude is dependent on interactions with other particles, with walls or components of the processing system, or with electrodes to which the particles are attracted. We have determined that, even though the conductivity of fine particles is small, it is possible for them to exchange charge readily even during a single interaction. It is believed this charge exchange is a consequence of conduction-induction phenomenon, and that electrical potential and/or interaction velocity play an important role in this exchange. Because of the fast nature of

such exchange, it may be necessary to control interactions with electrodes or metallic surfaces to increase the efficiency of a beneficiation process.

Charge and charge exchange is also dependent on particle size. This effect may be caused by the extent to which particles can interact and/or follow flow streams. For example, very fine (diameter < 10 μm) particles may not actually collide even under very turbulent processing because they follow flow streams better than larger particles; inertia is important in determining whether particles will or will not collide. Hence, we have also examined triboelectrostatic beneficiation for suites of samples which have been size classified, under wet and dry conditions. All of these phenomena, including the magnitude of charging, charge exchange and polarity reversal, are considered important and can influence beneficiation and product recovery. Part of our focus is trying to develop a greater understanding of the impact of these phenomena on dry beneficiation because so relatively little has been done in this field. The other focus of our dry beneficiation work is to assist in technology development and deployment, the progress and state of which will be described.